Energy depositions in materials

Simulations – 6 Nov status

- Started with the vessel materials:
  1 cm wood, 1m foam (70 kg/ m^3), 1.2 mm Stainless Steel membrane
- Same without foam
- Added LAr layers : 1 ,3 , 5 cm
- Simulated (FLUKA)
- Protons, Kaons, Pions, Kaons-, Pions-, electrons
- Perpendicular to layers
- Momenta: 0.2, 0.4, 0.5, 1.0, 2.0 GeV/c

Conclusions -6 November

- The effect of the SS membrane is acceptable
- 1m Foam is not
- 5cm LAr seem too much, will be the dominant term. Maybe charge can be recovered, surely not what is produced/intercepted by field cage.
- It would be beneficial to penetrate deeper inside the field cage
  - Avoid the region of field non-uniformity
  - Measure or at least identify backscattered particles

Engeneering meeting (last week)

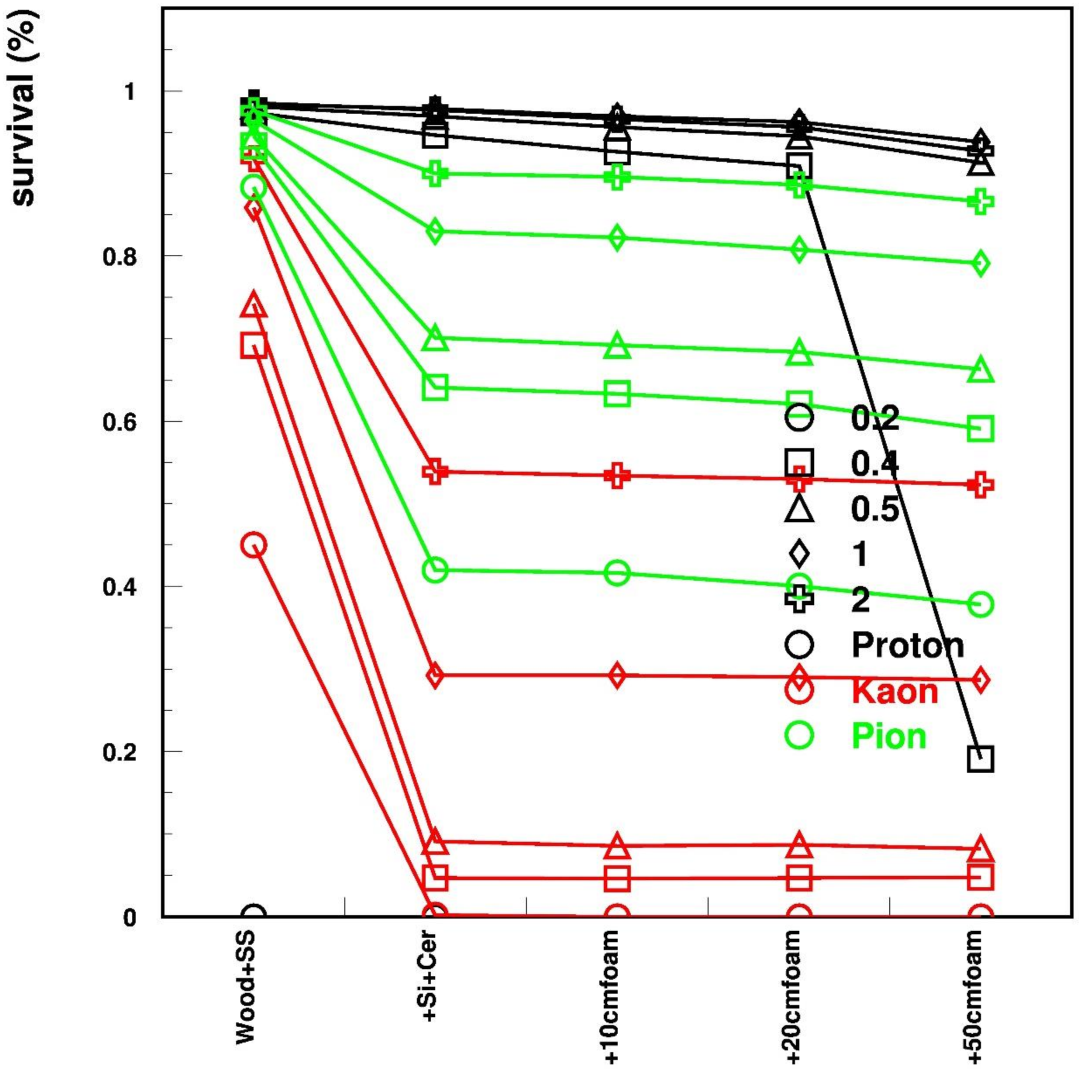
- Keep the membrane in place, important for structural reasons
- Penetration of the field cage is possible
- Will need a "tube" filled with low density material or vacuum within the LAr
- Input from the beam people:
- Materials of detectors in the beam line:
- Approx 1.5 mm silicon (three times two layers (x/y)) in vacuum, for trigger, position, time of flight
- Approx 1m gas plus 1mm Mylar windows for a Cerenkov detector, for particle identification. Can be removed for electron beam.
- Approximate distance from last bending magnet to cryo: 8m
- Beam dimension: 10 cm radius, fit 219mm diameter standard vacuum pipe.
- Beam divergency : approx. 1 mrad

New simulations:

- Assume that the 1.2mm SS membrane will stay there
- Assume 1cm of wood or equivalent attached to the membrane
- Add materials of detectors upstream
- (and start the particles at -800 cm..)
- Try different amounts of foam: 0, 10, 20, 50 cm at nominal density (70kg/m^3). Easy conversion to different density/length combinations

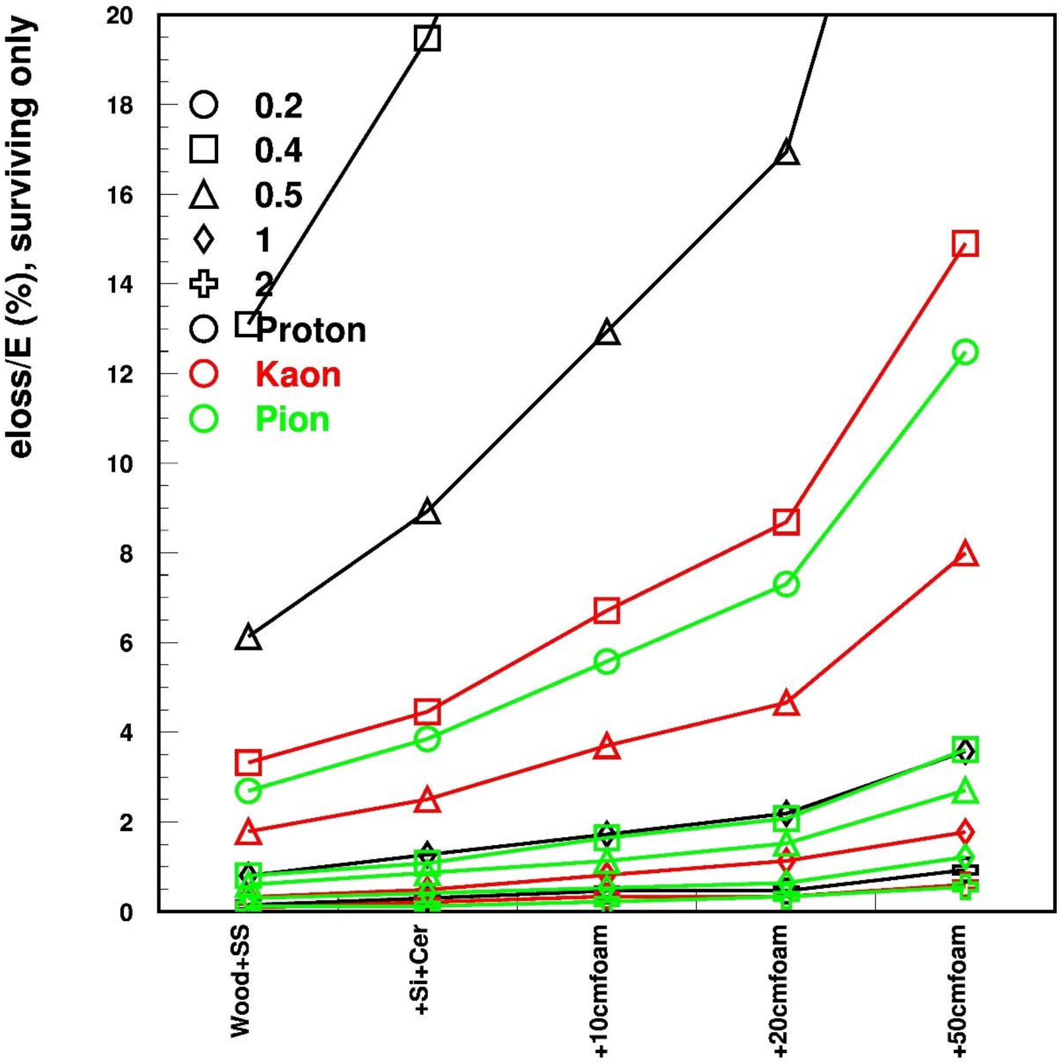
- Also: try to quantify the “backscatter”, work ongoing

Hadrons: Survival



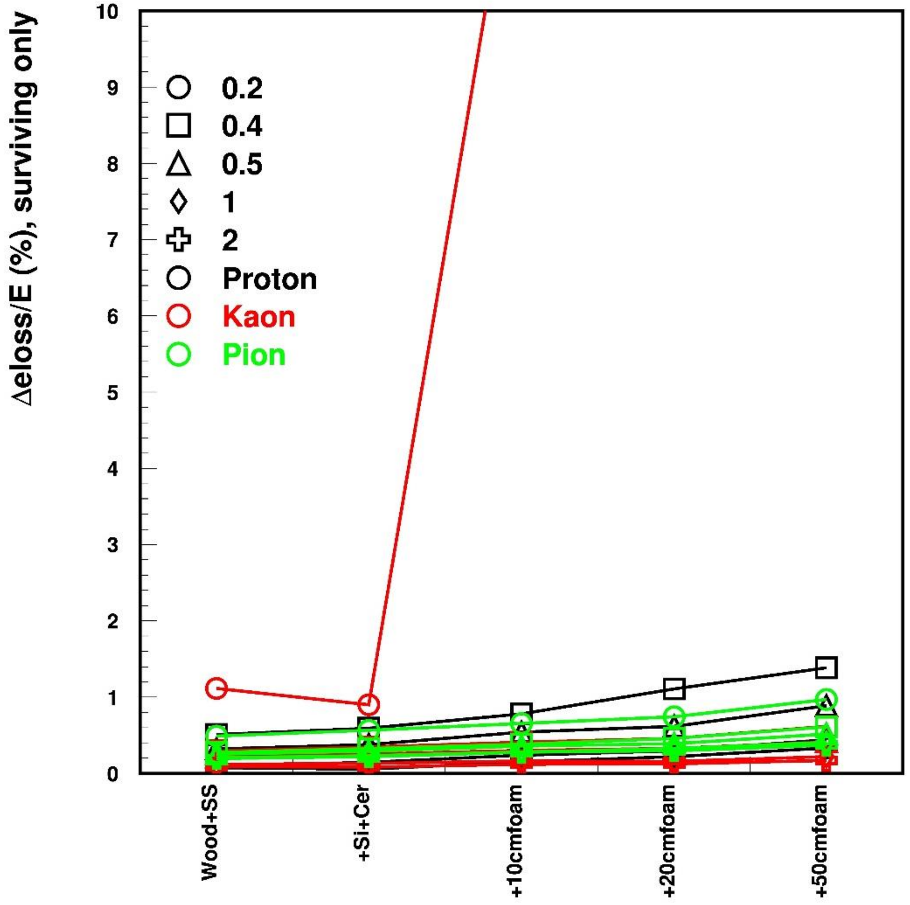
- Fraction of particles that do not interact or stop in the dead materials
- Different colors==particle type (only positive here)
- Different symbols: momenta
  - Oops..pions and kaons decay in the 8 m beam line....
  - Others: survival almost flat vs material budget

Fraction of energy loss, non-interacting hadrons



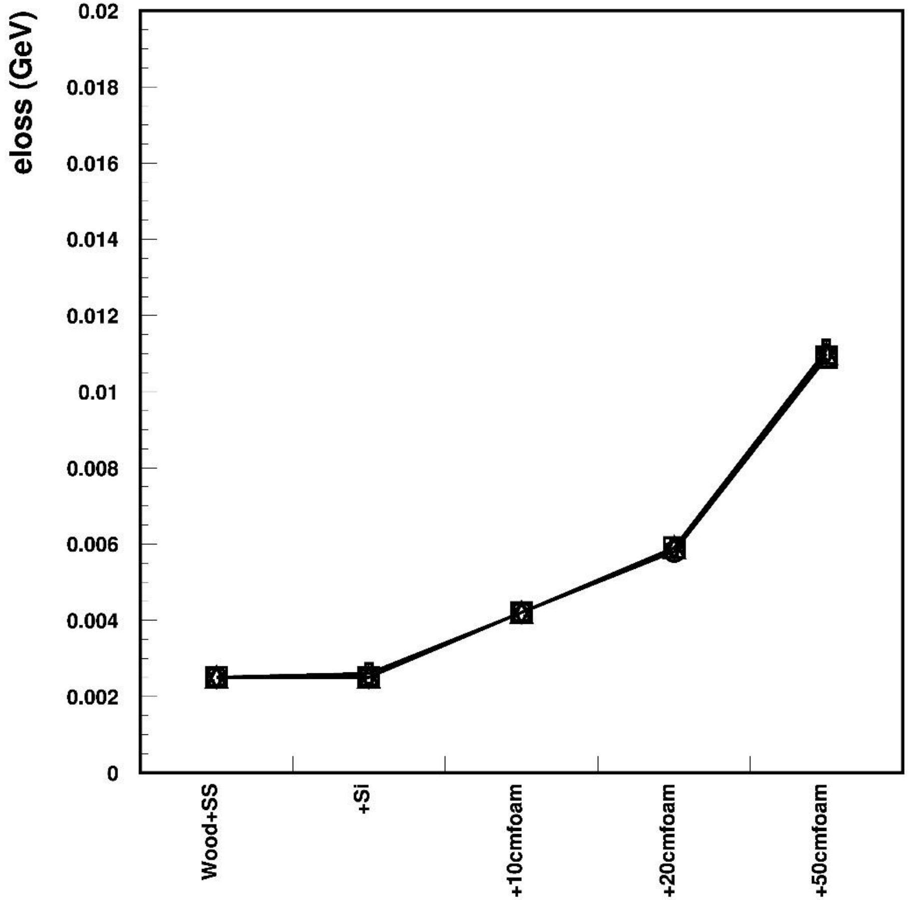
- Percentage energy loss for surviving particles
- Protons below 0.5 GeV/c (125 MeV kinetic) deteriorate quickly, do we really need them?
- For the rest, Eloss<10% up to 20cm of foam at least

Energy spread, hadrons



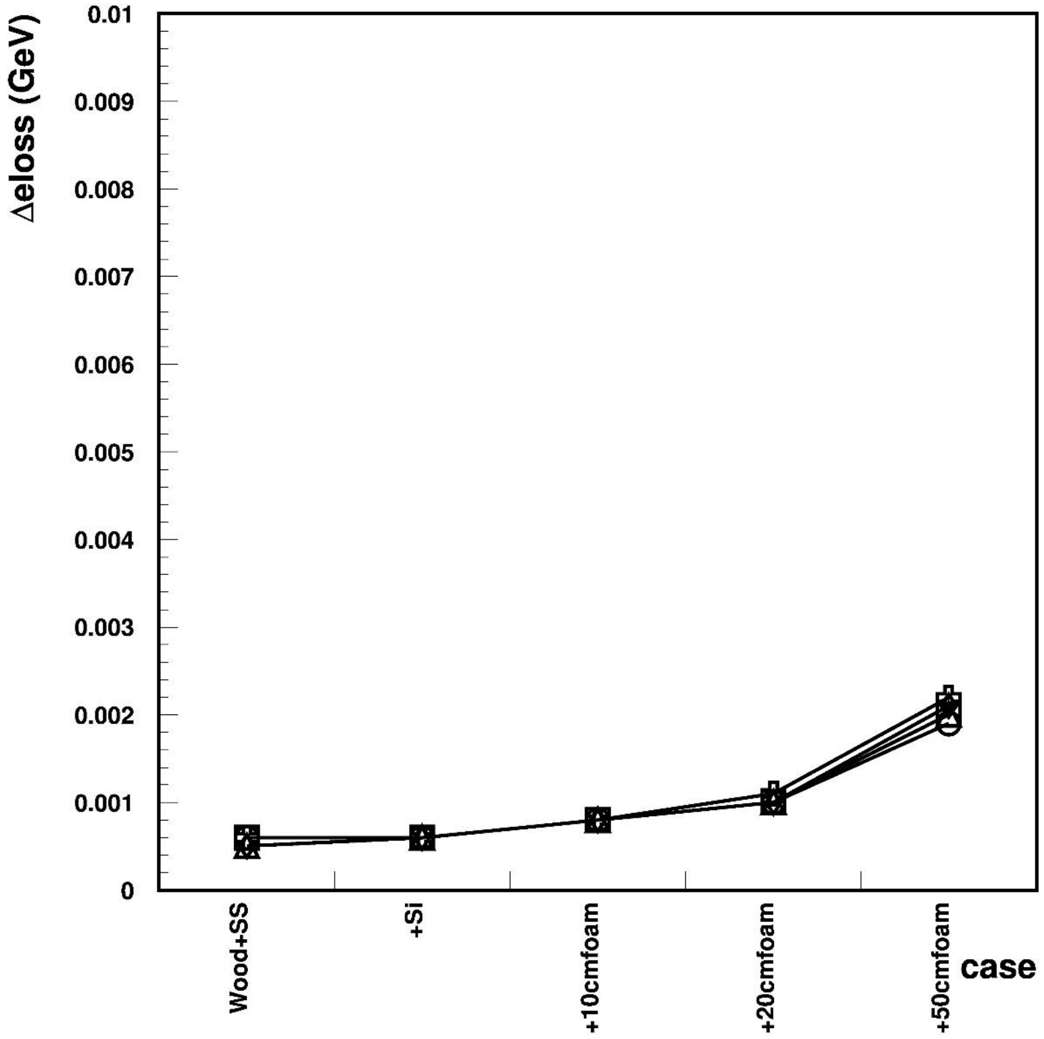
- Energy spread of "surviving" particles as a percentage of the original kinetic
- Stays <= 1% in most cases

Electrons: energy loss (no Cerenkov materials)



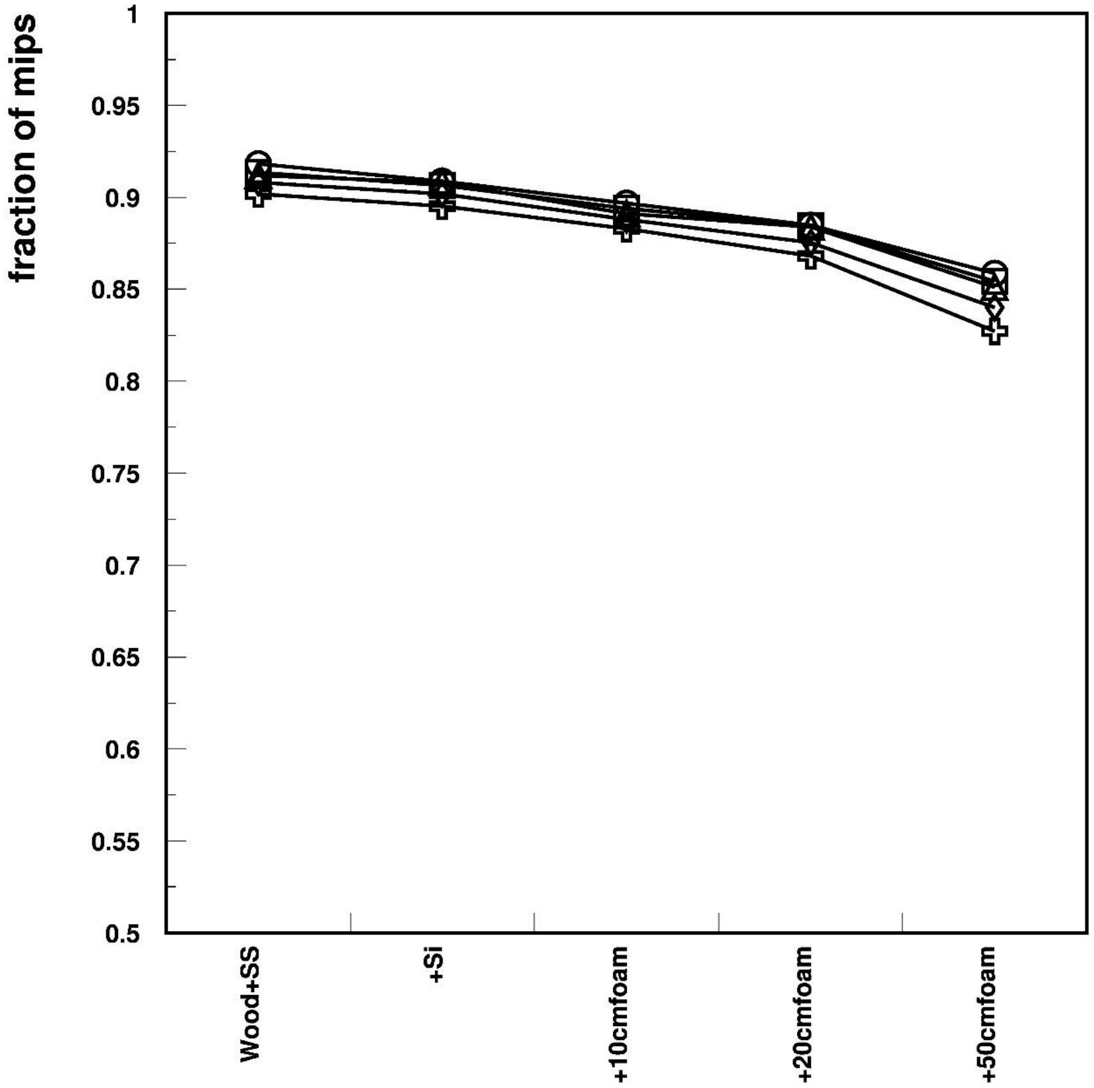
- For electrons no "non-interacting" concept
- Here: average energy deposited in dead layers
  - Membrane only: couple of MeV -)
  - Small effect from Si detectors

Electrons: spread of the E loss



- Spread of the energy loss (absolute value)
  - Membrane: fraction of MeV
  - Up to 50 cm foam: 2 MeV (order of 1% in fraction of original E for lowest energy beam)

Electrons: Fraction of "mips" after dead layers



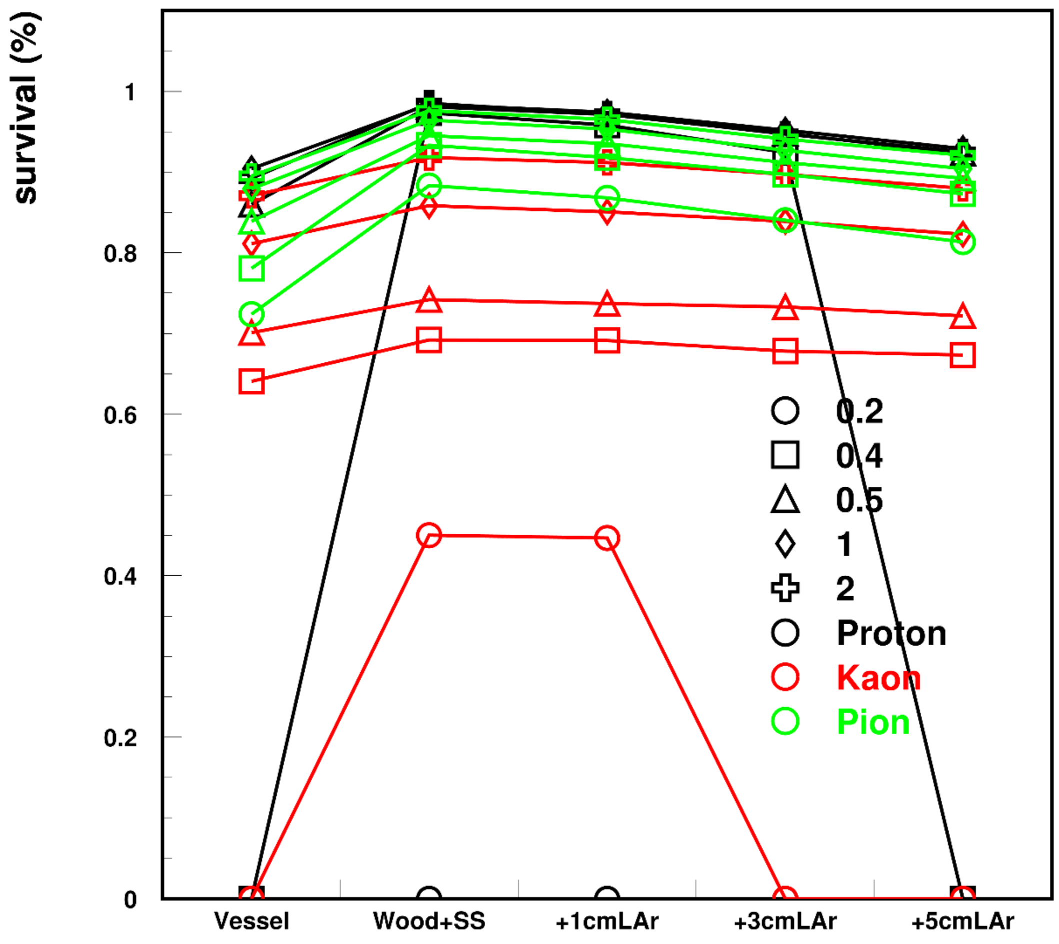
- **EXTREMELY ROUGH EVALUATION** of the fraction of electrons that are still "minimum ionizing particles" after the dead layers" , simply by dE in 1cm Ar
- Membrane: fine, 90% survive
- Small effect from Si
- Drops to 85% after 50 cm foam

conclusions

- Need discussion and input on what can be tolerated.

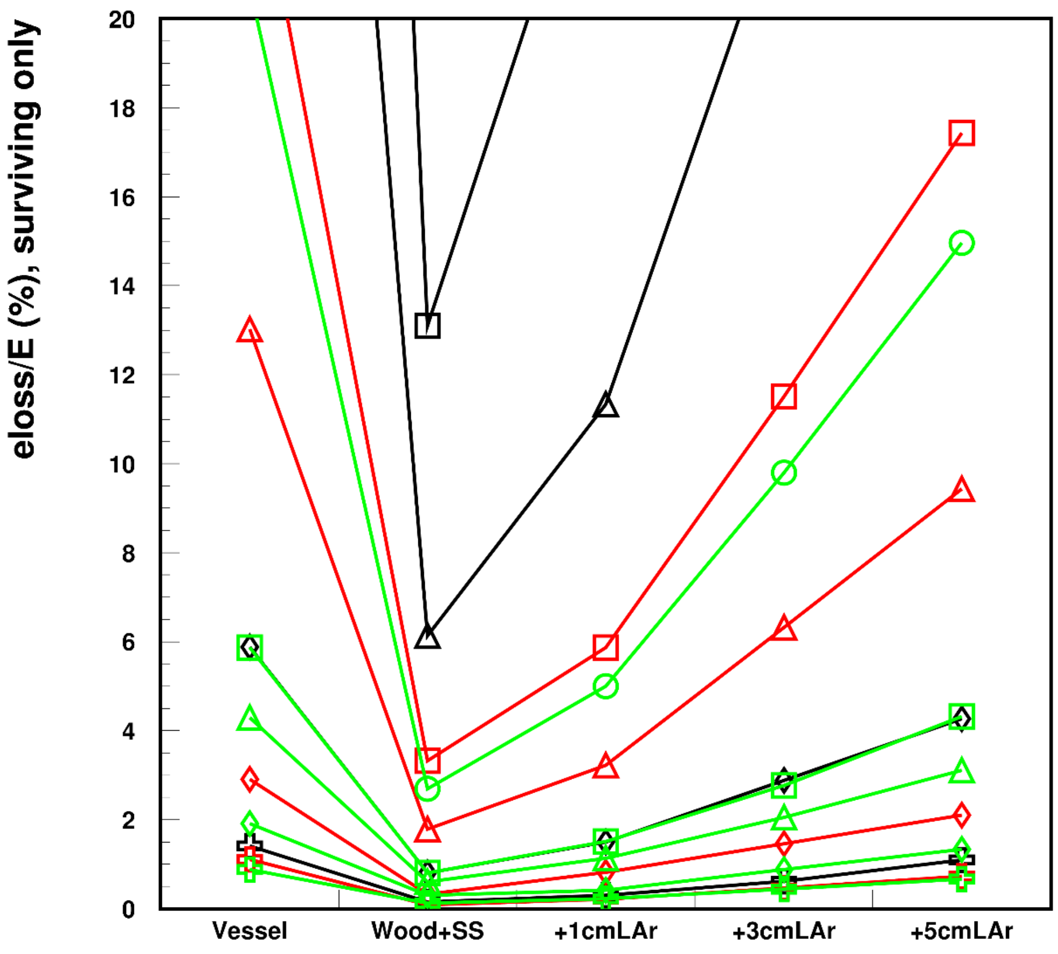
end

Hadrons: Survival



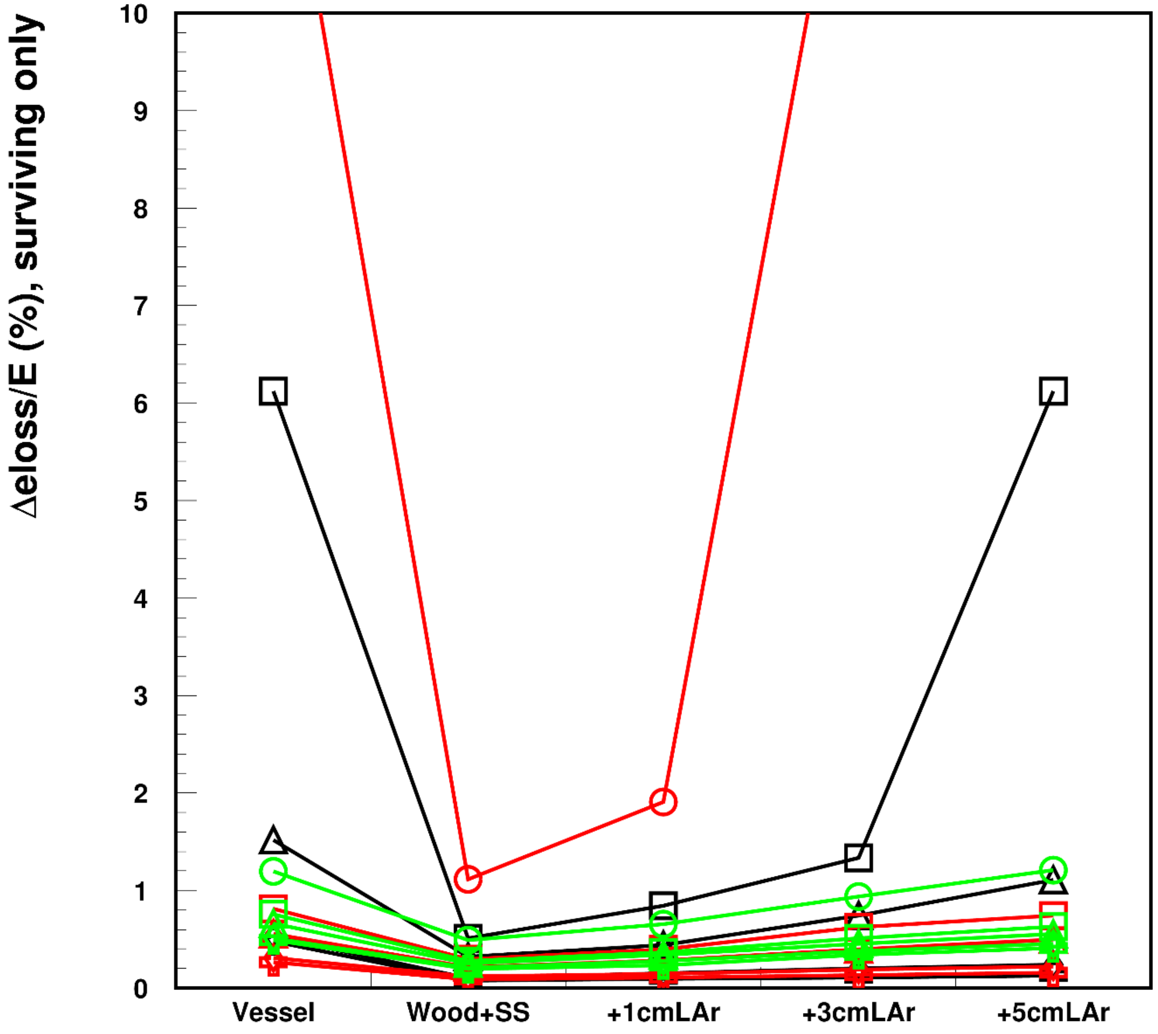
- Fraction of particles that do not interact or stop in the dead materials
- Different colors==particle type (only positive here)
- Different symbols: momenta
  - Very Low E protons /Kaons (p=0.2 GeV➔Ek=21 MeV for protons !) easily stopped
  - Others: survival almost flat vs material sandwich

Fraction of energy loss, non-interacting hadrons



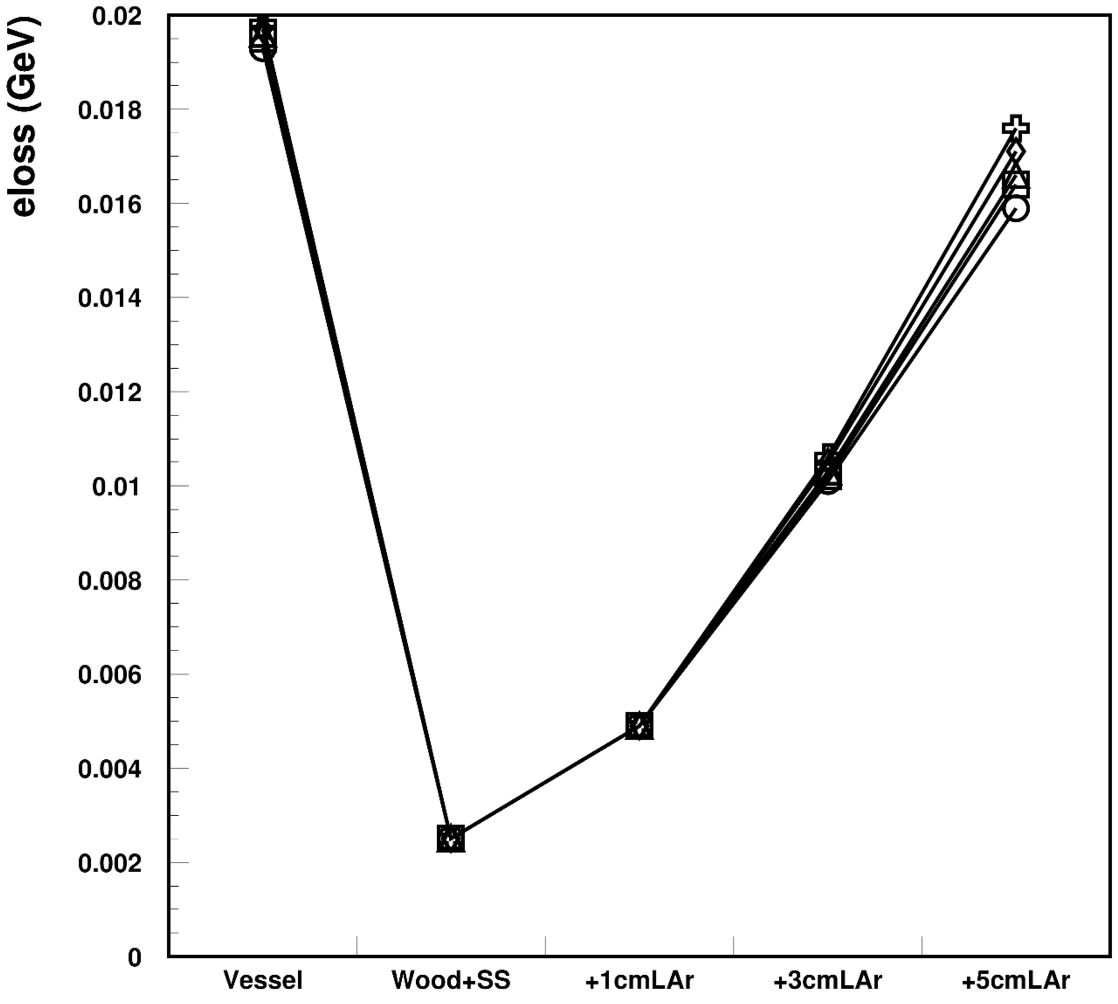
- Percentage energy loss for surviving particles
- Apart from protons, the existence of the SS membrane has a limited effect (below 5% energy loss)
- 1 m Foam does much more
- 5 cm of Lar->10% eloss for 0.5 GeV/c pions

Energy spread, hadrons



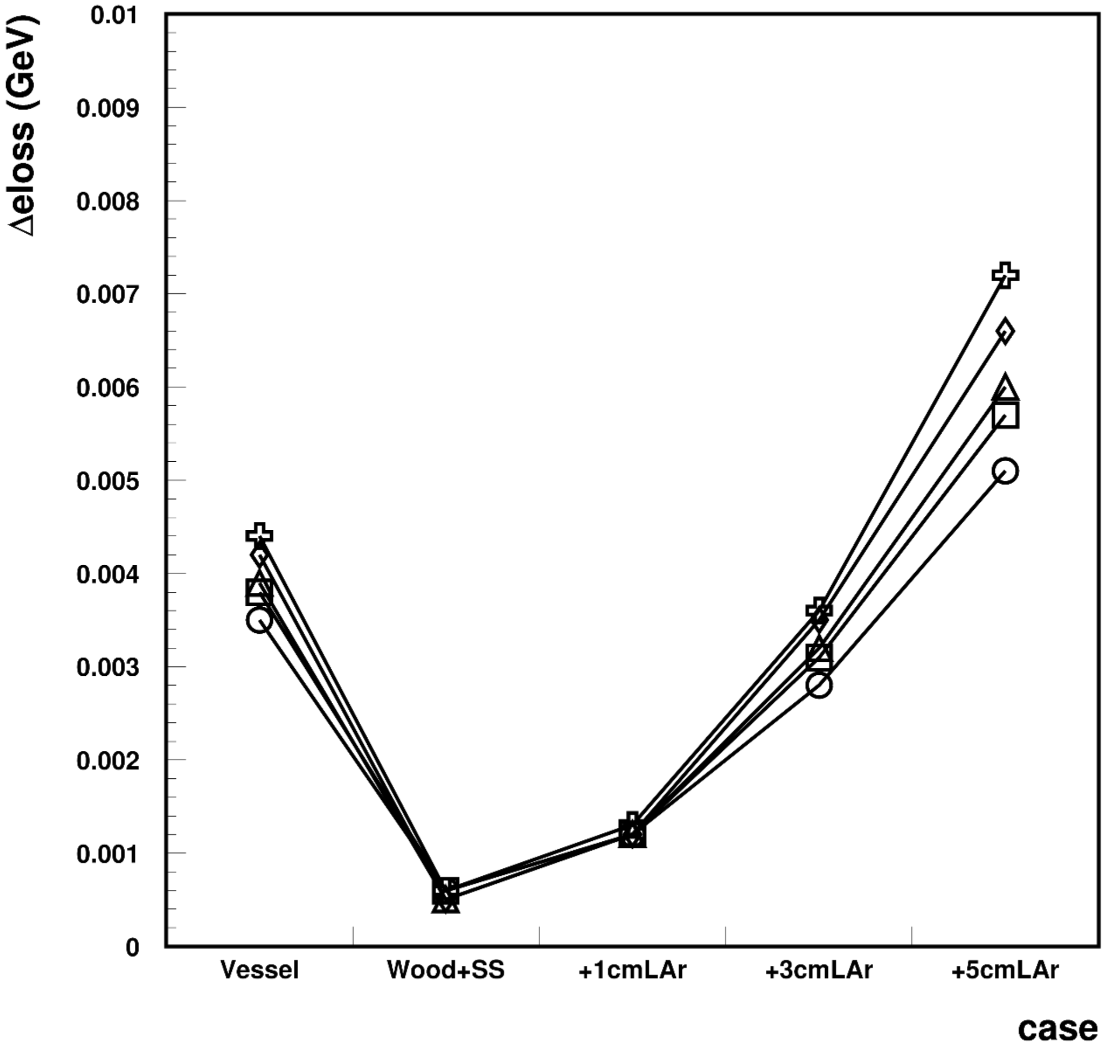
- Energy spread of "surviving" particles as a percentage of the original kinetic
- SS membrane acceptable (fraction of %)
- 3-5cm Lar → order of %

Electrons: energy loss



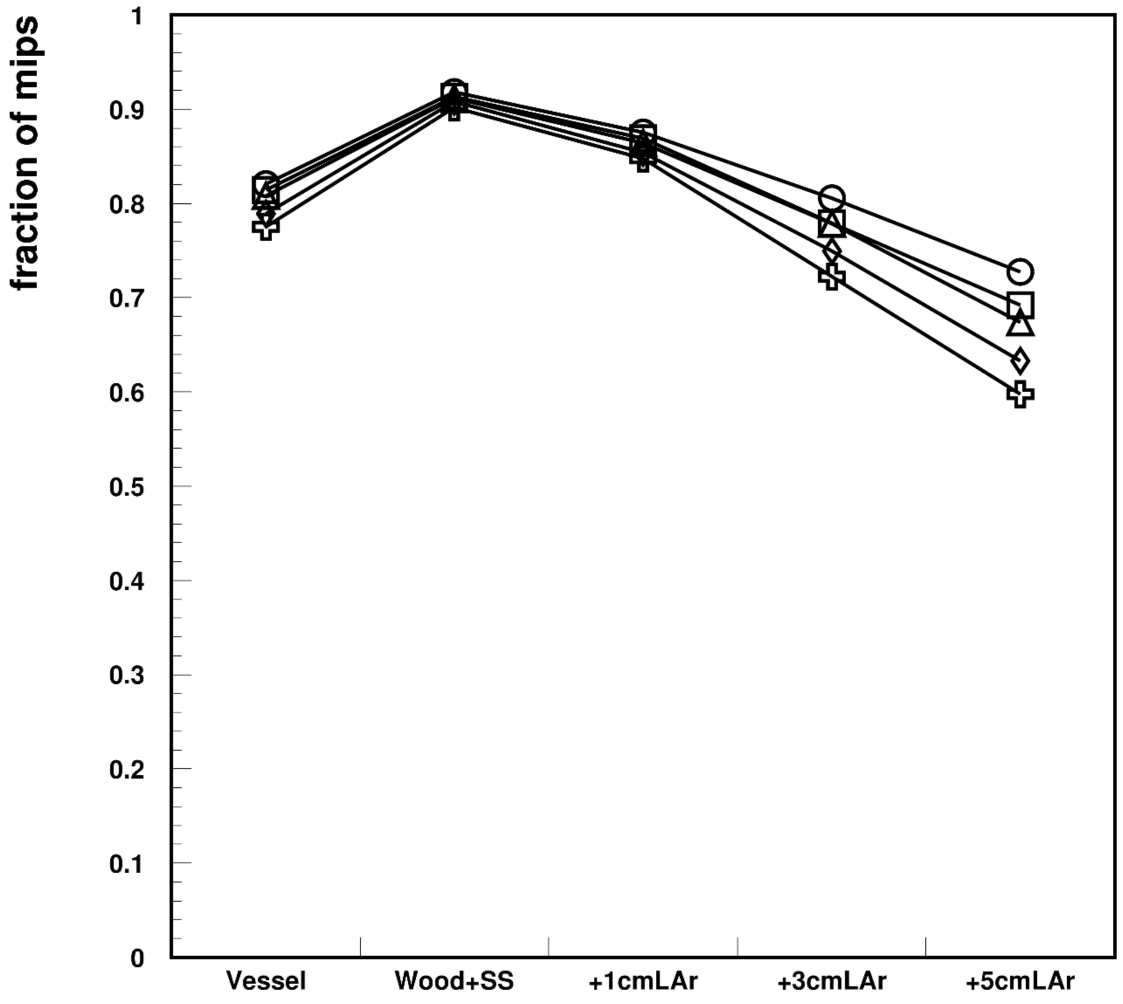
- For electrons no "non-interacting" concept
- Here: average energy deposited in dead layers
  - Membrane only: couple of MeV -)
  - 5 cm LAr → about 15 MeV (almost 10% at 0.2 GeV/c)
  - 1m foam has about the same effect of 5 cm LAr

Electrons: spread of the E loss



- Spread of the energy loss
  - Membrane: fraction of MeV
  - Adding materials: few MeV (order of few % in fraction of original E)

Electrons: Fraction of “mips” after dead layers



- **EXTREMELY ROUGH EVALUATION** of the fraction of electrons that are still “minimum ionizing particles” after the dead layers” , simly by dE in 1cm Ar
- Membrane: fine, 90% survive
- 5cm LAR: only 60-80 % survive

Backsplash vs containment

- We have also backward-going particles:
- What happens to containment if particles are injected just at the border of the active volume?
- How to reconstruct backwards?
- Would it be helpful/ necessary/possible to push the beam further inside?
- The plots on the right are Energy Deposition/cm^3 in average for 1 GeV/c π starting n the middle of a LAR box (at Z=500 cm)